INQUIRY INTO THE RELATIONSHIPS AND TAXONOMY OF THE MUSCOID FLIES.

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Dissections of the female reproductive system and studies of the eggs, first-stage maggots and reproductive habits of these flies, carried on for the past five years, have proved a golden key for unlocking many of the secrets connected with their relationships. Throughout the work, however, the problem of harmonizing these characters with those of the external adult anatomy has been a difficult one. At first sight the results seemed to indicate that the family groups heretofore recognized do not exist in the commonly accepted sense. The ordinary divisions seemed almost untenable, being often at variance with the results of the dissections or with external adult characters of well known utility.

It was soon evident that no satisfactory classification could be built up on the reproductive system characters alone. As examples of the disagreement between reproductive and external adult characters, the *Phasiidae* show in part flat-ovate macrotype eggs without uterus, in part elongate eggs deposited subcutaneously, also without uterus; and, if the Rutiliine and related flies are included in the family, in part elongate subcylindrical eggs hatching in an elongate uterus. The *Exoristidae*, after being restricted greatly from their former limits, are still more markedly differentiated in type of reproductive system and egg, showing not only the three Phasiid types but a half dozen or more additional ones as well.

It is now quite apparent that the external adult characters can not be subordinated to the reproductive characters in quite a good many cases, though they can so be in other cases. It seems practically certain, for example, that parallel specializations of the reproductive system have arisen quite independently in these flies, and that marked and parallel differentiations of the facial plate have so arisen with far less frequency. Facial plate differentiation is largely dependent on a greater or less lapse of oral and antennal functions, and such lapse is not of frequent occurrence. Reproductive system and egg modifications manifestly play an extensive part in the economies of these flies, wherefrom we may conclude that the reproductive system is plastic in a greater degree

than is the facial plate. Subtribal to subfamily should be attributed to the characters of the reproductive system, eggs and first-stage maggots, with family values under certain circumstances. When the true or incubating uterus is present its main type is a character of high value. The structure of the egg-chorion and certain structural details of the first-stage maggot are characters of still higher value. When such characters as these are supported by others they may well be used in family definitions. Practically all the early-stage, egg and reproductive - system characters are especially important and serviceable to us as indicating positively the natural limits of taxonomic groups, whereby we can with certainty draw a fixed line between those groups whose individual forms often can not be separated on the external adult characters.

A classification of the Muscoidea into family divisions founded on the general character of the egg, whether elongate-subcylindrical or flattened-ovate, is quite out of the question considering the external characters of the flies themselves; one founded on elongate uteri, or the absence of uterus, or on maggots developing in the uterus, would result similarly in an artificial and unnatural grouping. This may be realized by studying the tabular summary at the end of this paper. But there are certain other characters exhibited here that will apply to family divisions. For example the old family *Sarcophagidae* may well be restored in a new sense on the characters of the cordate and V-shaped uterus, both types being a double-sac specialization of the uterovagina quite distinct in character from all the other forms of uterine specialization in the Muscoidea. This division is strengthened by the generalized character of the cephalopharyngeal skeleton in the first-stage maggot of most of the forms, and by the deeply-sunken anal-stigmatic cavity of all the maggot stages. Employing the uterine character it becomes now for the first time possible to define positively and accurately the limits of this family.

It now seems equally desirable to restore the old family *Dexiidae*, but in a new sense, on a combination of facial plate and accessory supporting characters, definitely limited by the reproductive and especially by the first stage cephalopharyngeal characters. This is a natural group intermediate in facial-plate evolution

between the Muscid-Masiceratid stocks on the one hand and the Megaprosopid-Cuterebrid stocks on the other. We return at this point to an approximation of the group concepts of Schiner, who had an excellent eye for main natural distinctions in the Diptera.

The Megaprosopid type is clearly, though not closely, allied with the Dexiid, but its facial plate structure is closer to the Oestrid type than to the Dexiid, while the uterus and first-stage maggot as well as the cephalopharyngeal skeleton of latter differ markedly from those of the Dexiidae; hence it is advisable to maintain the group separately for the sake of uniformity. There has been a differentiation of the facial plate in the *Sarcophagidae*; the Paramacronychiine, Miltogrammine and Macronychiine types exhibiting a successive specialization in the direction of the Dexiid and Megaprosopid-Oestrid types. This is a case in which the facial plate characters are subordinated to the reproductive. It must be noted that the family group *Dexiidae* as restored does not include the many forms of the Pseudodexiine and Pyrrhosiine types, all of which have the Exoristid facial plate, though many of them possess pubescent and even densely plumose arista.

There are two large and taxonomically very practicable groups heretofore left in the *Exoristidae* that may most advantageously be accorded family rank at the present time. These are the microtype-egg forms with leaf-oviposition habit so far as known, which constitute the *Masiceratidae*; and the minute-platelet, coloured-maggot forms with foliage-larviposition habit so far as known, which constitute the *Hystriciidae*. There are three main categories of the former differing in the shape of the maggots and eggs; besides which there are numerous types differing in the structure of the chorion, which quite certainly indicates much diversity of origin. Yet they form a group easily defined on dissection of the females, and taxonomically quite as tenable as the *Oestridae* and several other long-accepted families.

The group of which *Phasiopteryx* is the type merits family rank on the remarkable and, so far as yet known, unique change of the eggs in the uterus from microtype ovate to macrotype subcylindrical, indicating wide separation from other stocks; not to mention the very exceptional structure of the first-stage maggot, which is no doubt largely adaptive.

The Cuterebrine flies are likewise too aberrant a type to be longer included in the same family with any of the other groups. They seem to have sprung from some old Mesembrinine stock, but are to-day well removed from their nearest living relatives.

It is now 23 years since Brauer and von Bergenstamm used the names *Masiceratidae* and *Hystriciidae*, but in different senses from those here employed. The family names must be accredited to them, since they employed them for the family types. The *Masiceratidae* as here revised includes but a fragment of the group to which they gave the name, only two of their genera so far as we yet know falling in it, these being *Masicera* and *Ceromasia*. But it takes in many of their *Phocoreratidae* and *Blepharipoda*, all of their *Willistoniidae* and *Goniidae*, their section *Myxexorista* (1893) and some at least of their *Baumhaueriidae* and *Germariidae*. The *Hystriciidae* as here revised includes all of their *Hystriciidae* except *Tropidopsis* which belongs in the Pyrrhosiine subfamily (*Hexamera* is not known to me), all of their *Tachinidae*, *Tachinoidae*, *Micropalpidae* (*Homoeonychia* unknown to me) including their section *Erigone* (1893), and a very few of their *Pyrrhosiidae*. It is profitable to note these comparisons as showing how nearly these authors in certain cases approached and how widely in others they deviated from proper definition of the groups on a study of the external adult characters alone.

If the peculiar reproductive and early-stage characters of *Phasiopteryx* are found to exist in *Oestrophasia*, the family will take the name *Oestrophasiidae* B. B. (1889). The name *Cuterebridae* was used in the present sense by Brauer and von Bergenstamm in 1889, but the family was ranked as an "Unter-Gruppe."

The *Sarcophagidae* of the present paper includes a large part of the *Sarcophagidae* B. B., a part at least of their *Rhinophoridae*, probably a part of their *Phytoidae*, probably all of their *Miltogrammidae* and *Paramacronychiidae*, and *Macronychia* alone of their *Macronychiidae*. In 1893 they referred *Melanophrys* to their *Paramacronychiidae*, but this genus belongs to the *Hystriciidae* of the present paper. The *Dexiidae* as here revised includes practically all of the *Dexiidae* B. B., and nearly all of their *Paradexiidae*.

From various comparisons we are able to judge with considerable certainty that the characters of the less adaptive struc-

tures of the egg and first-stage maggot are, on the whole, of prime taxonomic rank in the Muscoidae. They are therefore available for family definition in the case of large groups or pronounced types where other characters fail us. We may also justly conclude that the reproductive system and general egg and maggot structures furnish characters of inferior rank but of great service in the definition of such taxonomic categories as genera, group-units, subtribes, tribes and subfamilies, and even at times of families if they are supported by other important characters.

A comparative study of plant and animal taxonomy suggests (1) that the eggs, embryos, early and adolescent stages of animals will always furnish us the main key to their affinities whether such is present or lacking in the adult; (2) that the characters of the reproductive system, while of less rank, will enable us to fix definitely the limits of the lower taxonomic categories when their definition is obscured in the adult; and finally (3) that the more a structure becomes specialized, the more the taxonomic value of its characters contracts. The first point justifies the erection of the eleven families outlined and recognized in this paper. The last point emphasizes again the extreme taxonomic difficulties that exist in the muscoid flies, which are undoubtedly not only among highly specialized but also among the most recently specialized of all arthropods and hence the most difficult to classify in a convenient system. However much the values of certain characters may contract, in other words however obscured may become the group relationships in the structures exhibiting these characters, we are nevertheless often compelled, in the absence of others more distinctive, to use them if we wish to define certain of the higher taxonomic categories. Thus, in order to attain the greatest degree of clearness and practicability, we should in actual practice limit our main group-definitions to the fundamental group-categories or lowest groups of genera in these flies, which have been called group-units. Each group-unit consists of the *typic genus* together with those *atypic genera* which are found to be more closely related to it than to any other typic genus. For definition of typic and atypic genera, see Tax. Musc. Flies, p. 11.; and for many pertinent considerations, pp. 7–13. As an example, *Exorista* may be taken as a typic genus, and *Euphorocera* as an atypic genus belonging

with it; these together form a basis for the Group-unit *Exoristiæ*.

The eleven family types indicated in the diagram farther on show pronounced adult characteristics which cause them to stand forth prominently, as in bas-relief, from the mass of the Muscoidea. These characteristics are reinforced by valuable characters drawn from the eggs, early stages and reproductive system. But the limits of the groups which these eleven family types represent are often greatly obscured in the external anatomy of the adult, and it is the function of the egg, early-stage and reproductive characters to clear up this obscurity in all cases. This is the first time in the history of muscoid taxonomy that we have had the means of definitely segregating these various families and accurately determining their limits, and they may well be maintained now on the sum-totals of their respective characters. But in synoptic treatment, as will appear later, these family groups are unwieldy and do not aid us as such, though their divisions may be employed as leading directly to the group-limits.
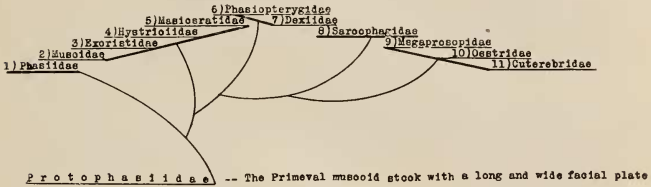
The characters of the facial plate apparently continue to hold better in the main for the indication of family types than do those of any other single external adult structure. They become subordinated to the characters of the female reproductive system and early stages occasionally, as in the case of the Sarcophagidae and Dexiidae, but this is in accordance with the well-known law of contraction of values, and the consequent fluctuation of characacters, which cannot hold for all groups. They are reinforced by various other external adult characters in the several groups. Where they fail from lack of differentiation to mark off otherwise prominent groups, the characters of the first and second categories are always available. The following scheme of derivations illustrates well, reading the group from left to right, the successive retrograde modifications of the facial plate that appear to have taken place in these flies.

(1) Phasid stem (Facial plate remains wide and elongate).

(2) Muscid (3) Exoristid (4) Hystriciid (5) Masiceratid stem (Facial plate shortens but remains wide).

(6) Phasiopterygid (7) Dexiid stem (Facial plate shortens further and becomes constricted below).

(8) Sarcophagid stem (Facial plate in the typical stock very

6)Phasiopterygidae
5)Masiceratidae — 7)Dexiidae
4)Hystriciidae — 8)Sarcophagidae
3)Exoristidae — 9)Megaprosopidae
2)Muscoidae — 10)Oestridae
1)Phasiidae — 11)Cuterebridae

Protophasiidae — The Primeval muscoid stock with a long and wide facial plate

similar to that of the Muscid stem, but some stocks show a short-
ening of clypeus and inferior constriction of the facial plate,
foreshadowing and even approximating those of the extreme
types).

(9) Megaprosopid (10) Oestrid (11) Cuterebrid stem (Facial
plate reaches extreme of clypeal shortening and epistomal con-
striction).

The lines of descent have not been simple, but on the con-
trary quite complex, and the plan merely indicates the general
trend in facial plate modification. From the Phasiid to the Oestrid
extremes the successively increasing differentiation may be traced
in successive types of ever greater clypeal shortening and epis-
tomal constriction. It seems almost certain that the facial plate
has specialized according to the retrogressive evolution here in-
dicated. There are several facts that appear to confirm this view
quite conclusively. Australia possesses no endemic oestrid nor
cuterebrid stock, but it has been the focus of a considerable number
of forms which must be considered as survivors of primitive phasiid
stock. These are *Rutilia*, *Amphibolia*, *Microtropeza*, *Paramphi-
bolia*, *Amenia*, *Senostoma* and *Chrysopasta*. Certain relatives of
these, also evidently to be classed as survivors of the same stock,
occur in the Australasian or Austromalaysian regions and streng-
then the case in hand. These are *Paramenia* of New Zealand,
Pseudoformosia of New Guinea, *Stilbomyia* of Java, and others. It
is to be noted that none of these, however, reaches either South
America or South Africa. Both of these continents were apparently
cut off from the Australian-Antarctic landmass at a time ante-
dating the greater or main dispersals of that branch of the primi-
tive phasiid stock which gave rise to these forms. These facts

indicate that the phasiid stocks are much older than the oestrid and cuterebrid stocks.

Other facts point to the same conclusion. The specialization toward partial and complete atrophy of the mouthparts in the oestrid stocks, toward partial atrophy of the same in the cuterebrid and megaprosopid stocks and toward antennal reduction in these and kindred stocks indicates that the extreme shortening and constriction of the facial plate are connected with a more or less complete loss of mouth and antennal functions. Certainly this is comparatively recent specialization, for the primitive stocks must have had highly functional mouthparts as well as high antennal development.

Facial plate reduction has probably followed antennal and mouth reduction. In other words it is a consequence of loss of nutritive and olfactory functions in the fly, and thus marks an extreme stage of parasitism and host-adaptation, particularly one in which the sexes may easily find each other, in which the female may easily find the host, and in which the maggots may easily store a large food-supply. The two muscoid stocks which are apparently of most recent evolution, the Masiceratid and Hystriciid, in which the mouthparts and antennæ are both still highly functional and the facial plate in consequence still retains its full development, have much less perfect host-relation, sex-relations and food-supply conditions. They must search assiduously for their hosts; the large fecundity which is necessary to their peculiar host-relations demands extensive feeding in the adult female, especially as she has not an unlimited food-supply during her larval life; and the necessity for feeding and host-searching makes the female a wanderer, whose discovery by the male calls for well-developed olfactory organs.

The comparison of *Cobboldia* with other types shows conclusively that pharyngeal atrophy (atrophy of pharynx and rostrum of proboscis, and not necessarily of haustellum or palpi, with more or less complete closure of pharyngeal cavity) is directly correlated with the evenly receding and gently-convex profile of the facial plate and peristomalia, and the consequent more or less complete recession of the epistoma; further that the great shortening of the clypeus is primarily dependent on and thus directly

correlated with antennal atrophy (atrophy practically only of the third joint, and consequent loss of olfactory function).

As correlated in importance with facial plate specialization among external adult characters but of less value, it is interesting to note that excessive macrochaetal development has taken place in several stocks and probably by parallelism. The following groups, arranged by families, exhibit spinose-macrochaetal specialization:—*Hystriciidae*, the climax of all (*Dejeanini, Saundersiini* pt., *Hystriciini*, and *Larvaevorini* pt.); *Masiceratidae* (*Blepharipezini, Belvosiini* pt.); *Exoristidae* (*Pyrrhosiinae* pt.—*Tropidopsis* and *Paragymnomma*); *Dexiidae* (G.-U. s. *Echinodexiiæ,Tropidodexiiæ*); *Megaprosopidæ* (G.-U. *Megaprosopiæ*); *Phasiidae* (G.-U. *Amphiboliiæ*).

The wisdom of separating the *Megaprosopidæ* from the *Dexiidæ* and of maintaining them on a par with and more allied to the *Oestridae* may be questioned. It may be argued that the presence of macrochaetae allies them more with the *Dexiidae*. We know, however, that their maggots are of peculiar structure, that of *Microphthalma* at least being quite thickly clothed with long bristly hairs and representing the extreme development of bristly vestiture in the first-stage maggots so far as known, while its cephalopharyngeal skeleton is of a distinct type from the dexiid. Their uteri are of markedly different type from the form typical of the *Dexiidæ*, being known to be very long and irregularly coiled in both *Microphthalma* and *Megaprosopus*. Their segregation is thereby demanded since these characters strongly reinforce those of the facial plate. The absence of macrochaetae in the oestrids is due to their aerial life-habit, which is not shared by the Megaprosopids.

It is possible, notwithstanding the facial and oral characters, that the *Trixodini* may be found on investigation of their reproductive system and first-stage maggots to belong with the *Dexiidæ* rather than with the *Megaprosopidae*. They almost certainly have a uterus of the continuous-canal type and it is quite possibly of the fat and shortened dexiid type, but the final test of family position here will lie in the type of pharyngeal sclerite possessed by the first-stage maggot. These flies are very rare, at least in collections. The only known specimens are two collected by myself on tree-trunks in the mountains of the Rio Gila headwaters in

New Mexico and the Sierra Madre of Chihuahua. During a trip across the Sierra Madre of Chihuahua and Sinaloa in August and September, 1909, I made especial search for these forms but found none. A similar search earlier in the season would probably have been successful. These flies are of unusual interest as exhibiting facial and oral characters intermediate between those of the *Megaprosopidae* and those of the *Oestridae*, while their weak macrochaetae show a further trend toward the latter family. It is probable that they parasitize wood-boring larvæ.

If, as seems very certain, *Rutilia* and *Amphibolia* represent an old stock, then uterine development must be of very long standing. Both forms have coiled uterus in which the elongate eggs hatch. Certainly a type without incubating uterus would seem to be the original, and elongate subcylindrical eggs should be the more primitive form. If this is true, we must go well back into the past for the beginnings of the remarkable specialization in reproductive system, eggs and maggots of these flies. These specializations have quite certainly been largely adaptive, and thus we are better prepared to accept their independent origin in several stocks. Ovate, flattened eggs are an adaptation for attachment to surfaces, the larger or macrotype forms being designed for fastening externally to host and the small or microtype forms for fastening to leaf-surfaces to be swallowed by host. Here is extensive adaptation even in size —a specialization to a microscopic egg that can be swallowed by leaf-feeding insects without injury to the contained maggot. This last specialization seems to have arisen independently in several stocks, since these eggs exhibit a wholly unexpected variety of structure, the choria of some being reticulate after a honeycomb pattern, those of others having a pattern of raised arcs or wrinkles, while some have a perfectly smooth and unreticulate chorion, and still others have the chorion finely or coarsely punctured or finely or coarsely set with raised points.

Pediceled eggs are for attachment to hosts in place of flattened eggs. If neither pedicel nor flatness can be secured, nor viscid secretion for gluing the eggs nor structures for depositing them subcutaneously, then in order to meet the requirements of parasitism the eggs must be held in the uterus until the maggots are

fully developed and have become highly active. Hence the need for special uterine development. So far as yet known no elongate unpediceled eggs are ever deposited on hosts except by the Gastrophiline Cobboldiine and Cuterebrine flies, whose eggs are provided with a profuse viscid coating for attachment by their lateral or latero-anal surfaces to the hairs of the host. In this connection it also becomes evident that forms affecting a host to which the fly can not gain access must possess a uterus in which to develop active maggots that can search for and penetrate to such hosts.

Some maggot-depositing flies, on the other hand, which have what would seem the most perfect access to the host are most careful to keep at a certain distance from the latter. Such are the *Hystriciidae* or leaf-larvipositing forms which are greatly specialized in their coloured maggots, long coiled strap-like uterus, consolidated cephalopharyngeal skeleton and excessive macrochaetal development. Their very divergent host-relations may be in part due to certain of their hosts living in webbed nests and being in the habit of spinning sundry silken threads both for enlarging and changing their habitations and for marking their feeding trails whereby they may retrace their way to the nest. Silken webs are especially dangerous to forms of excessive macrochaetal development; and it may be that there is some connection between this and the origin of this remarkable host-habit, with the consequent coloration of the maggot.

Even more consolidated than in the *Hystriciidae* is the cephalopharyngeal skeleton of the first-stage maggot in the *Masiceratidae* or leaf-ovipositing forms, in which his structure has reached the extreme of reduction and consolidation. This argues for a high degree of specialization here, of longer standing than that of the leaf-larviposition forms. The conclusion is borne out by the elongate intestiniform uterus, microscopic size of the egg, and the remarkably divergent host relations whereby it becomes necessary fully to develop the maggot within the chorion without allowing it to escape therefrom until it shall have arrived in the alimentary canal of the host, notwithstanding that it may remain for a considerable time deposited and unswallowed. Such provisions mark an extreme specialization of very long standing. How these microscopic eggs could have originally arisen from a

larger type, as we must needs conclude they have done, in sufficient mode to become established, necessitating corresponding marked changes in the oviposition habits and thus in the instincts of the female, is a fascinating problem for solution. It seems certain, moreover, that such eggs have arisen independently in several different stocks, but probably largely through parallelism due to evolution trend.

The flies with subcutaneous host-larviposition habits and those with subcutaneous host-oviposition habits are likewise much specialized. The remarkably specialized piercers, larvipositors, ovipositors, combinations of these, and accessory structures such as the ventral carina and its spinules denote high specialization. During copulation the piercing structures have evidently to be extended or thrown far backward, in the *Compsiluriæ* at least, for effecting the union of the vaginal orifice with the male.

While *Phasiopteryx* appears to be a waning survivor of an old stock with dexiid affinities, it exhibits a large amount of specialization in its very long and slender uterus and especially in its very differentiated isopodiform maggot with chitinized segmental lateral and dorsal plates. But what holds the utmost attention and interest in this form is the wholly unique character of the ova accomplishing in the upper part of the uterus their final growth or increase in size to the fully formed macrotype egg, which should by analogy with other macrotype-egg forms have been completed in the ovarioles. This seems difficult of explanation and, of course, at once suggests some connection with the microtype-egg or leaf-ovipositing forms. But *Phasiopteryx* is to all appearances of external structure far removed from the microtype-egg stocks. Its uterus is very similar in general form to that of the *Phasiatactiæ* and *Cnephalomyiiæ*, both of which have an elongate and more or less pointed microtype egg that is flattened ventrally. Its facial plate is not so divergent in type as to preclude a common origin with the masiceratid stocks. It seems probable that we must look on *Phasiopteryx* as a remnant of an offshoot from some ancient microtype-egg stock. If this view is correct, we may expect important light on phylogeny of the microtype-egg stocks from a thorough study of this genus and its allies. It appears quite

certain from the facts in the case that the ancestors of *Phasiopteryx* possessed a microtype egg.

It is a general rule throughout the Muscoidea that those groups with greatest fecundity comprise parasitic forms whose host-habits afford their maggots the least favourable opportunity for encountering the host. Conversely the opposite is the case. The fecundity runs highest in the *Masiceratidæ* and *Hystriciidæ*, leaf-ovipositing and leaf-larvipositing parasitic forms, the latter exhibiting the extreme Thus we may conclude that in these groups there occurs the highest maggot mortality. Those forms which are parasitic in white grubs, wood-boring grubs, and hosts in general which the maggot must seek out for itself with limited chance of finding them also have a high fecundity. The *Myiophasiiæ*, which are weevil-grub parasites, have a much lower fecundity, and it is evident that their maggots usually reach the host. Forms which deposit eggs or maggots on the host also have a comparatively low fecundity, and those which inject the maggots or eggs subcutaneously have a still lower fecundity. The typical Sarcophagine flies, which are non-parasitic in the strict sense, show on the whole the lowest fecundity of all, due to the nature of their larval food-substances on which the highly active maggots are deposited and which is ordinarily bountiful for their needs.

The Sarcophagine flies have perhaps developed maggots *in utero* on account of the generally perishable nature of their larval food-substances, combined with a fairly long incubation period necessary to the development of the maggot. On the other hand the muscine and calliphorine flies have not done so, on account of a marked difference in the nature of their food-substances which are in general less perishable, combined with an incubation period sufficiently short to meet the conditions and requirements of oviposition. It may be here pointed out that the most generalized type of cephalopharyngeal skeleton so far known in the Muscoidea is that exhibited in the first-stage maggots of the Sarcophagine flies and their allies. Evidently the sclerites have here remained almost unspecialized, being unreduced and freely articulated, as best fitted for their larval life-habit.

Returning again to taxonomic considerations, it is necessary to point out more fully that however well the family types al-

ready outlined may stand forth on general characters, it is never-
theless true that the recognition of the family groups which they
typify does not facilitate synoptic treatment. Their employment
does not elucidate the subject, but rather obscures it. They are
often incapable of concise limitation and hence of compact synop-
tic definition on either external, reproductive or early-stage charac-
ters. Thus it is necessary to sidetrack them in actual synoptic
practice and drop to lower categories. The group-unit is the
category that here lends itself most conveniently to taxonomic
manipulation. The reason for this lies in the fact that the charac-
ters of the reproductive system, egg and early stages, which can
not always be conveniently interpreted as of family value, and
often of subfamily or even of subtribal value, are much more
pronounced and readily apparent, therefore more comprehensive,
than those characters of the external anatomy of the fly which
largely mark convenient family to subtribal divisions. While the
characters of the facial plate and various supporting characters
of family to subtribal importance exhibited by other external
adult structures are often by themselves almost impossible of
correct interpretation, so much so that hardly any two persons
can be expected to read them alike, those of the reproductive
system, egg and early stages are unmistakable and impossible of
confusion.

Such external adult characters as the more or less ciliate
facialia, degree of hairiness of eyes, apical cell ending at or near
wing-tip, presence of true macrochaetae, hind tibiæ ciliate or
pectinate, relative length of aristal and antennal joints, relative
development of antennæ, mouth-parts and palpi, and especially
exact plan of facial plate specialization including degree of con-
striction by vibrissal angles and their comparative degree of
removal from the oral margin with the conformation of latter,
in fact the majority of the external adult characters in these flies,
are very difficult to describe accurately and few persons will be
able correctly to interpret the descriptions in any event. More-
over these characters indicate close relationships only in certain
cases, while in others they are the result of evolutional trend in
stocks considerably removed from each other. For this and
other reasons their value runs out at times. In certain groups

some of these characters become highly untrustworthy, though they may hold good throughout other groups. It is often quite impossible to decide their values correctly without the aid of the reproductive and early-stage characters to guide us in the matter of close relationships. An intricately interrelated system of specialization in external adult anatomy has resulted in producing in distinct stock forms which closely approach each other in external characters. This was not realized until the investigation of the reproductive and early-stage characters had considerably progressed.

Until this work was well under way no one could interpret the genera as they actually exist, and all generic work was largely guess-work. Even at the present time muscoid genera as they commonly appear in the literature are in numerous cases complexes of widely different stocks. Forms belonging to distinct families have for a century been classed as congeneric, and the external differences between them are sometimes so inconspicuous that careless workers have even pronounced them conspecific. These facts serve to emphasize the invaluable aid to be derived from the reproductive and early-stage characters, and the necessity for taxonomic manipulation of the superfamily by means of smaller groups than families, subfamilies, tribes, and subtribes.

The following tabular summary will be useful. It shows the known main differentiations of the female reproductive system, eggs and first-stage maggots in /the eleven muscoid families here recognized, exemplified by group-units. The group-unit consists, as already stated, of the typic genus plus the atypic genera which belong with it, and is a division of the subtribe.

Its ending is *iæ*, which is added to the root of the name of its typic genus.

I. PHASIIDÆ

1. Elongate macrotype eggs deposited subcutaneously without incubation, no uterus—Phasiiæ.

2. Flattened subovate macrotype eggs deposited supracutaneously without incubation, no uterus—Ectophasiiæ, Trichopodiæ, Xanthome-

I. PHASIIDÆ
(Continued from page 51.)

lanodiæ, Cistogasteriæ, Rhodogyniæ.

3. Elongate subcylindrical macrotype eggs hatched in coiled uterus—Rutiliiæ, Amphiboliiæ.

II. MUSCIDÆ

1. Elongate subcylindrical macrotype eggs, no uterus—Musciæ, Stomoxydiæ, Calliphoriæ.

2. Elongate macrotype eggs incubated in uterus, deposited as free maggots or maggots in choria—Mesembriniæ, Hypodermodiæ, Eumusciæ.

3. Elongate macrotype eggs hatched in uterus and maggot carried to or through its third stage therein—Dasyphoriæ, Glossiniæ.

III. EXORISTIDÆ

1. Flattened ovate macrotype eggs deposited supracutaneously without incubation, no uterus—Exoristiæ, Plagiopiæ, Winthemiiæ, Neophoroceratiæ, Chaetotachiniæ.

2. Flattened subovate macrotype eggs incubated but not hatched in coiled uterus, deposited supracutaneously—Meigeniiæ, Vivianiiæ, Cyrptomeigeniiæ, Thrixioniæ.

3. Elongate subcylindrical pediceled macrotype eggs incubated but not hatched in coiled uterus, deposited supracutaneously—Carceliiæ.

4. Elongate macrotype eggs deposited subcutaneously without incubation, no uterus—Phaniiæ, Hemydiæ, Leucostomiæ, Dionaeiæ.

5. Elongate macrotype eggs hatching

to white maggots, slender coiled uterus, the maggots deposited sub-cutaneously—Compsiluriæ, Cela-toriiæ, Oxynopiæ, Weberiiæ.

6. Elongate macrotype eggs hatching to white maggots in slender coiled uterus like preceding, but the mag-gots deposited supracutaneously—Pseudomyothyriiæ, Hyalomyodiæ, Thryptoceratiæ.

7. Elongate subcylindrical macrotype eggs hatching to coloured maggots in coiled very long and slender to fat gut-like uterus, the maggots deposited near host—Eugymno-chaetiæ, Bigonichaetiæ, Glauco-phaniæ, Eriothryginæ, Macquar-tiiæ, Ophirioniæ, Steinielliæ.

8. Elongate macrotype eggs hatching to white maggots in short, fat gut-like coiled uterus, the maggots de-posited near host—Eumyobiiæ, Pyrrhosiiæ, Ophirodexiiæ, Atro-phopodiæ, Thelairiæ.

9. Elongate subcylindrical macrotype eggs hatching to white maggots in coiled strap-like uterus, the mag-gots deposited supracutaneously—Zygosturmiiæ, Azygo bothriiæ, Voriiæ, Siphosturmiiæ, Eryciiæ.

III. EXORISTIDÆ
(Continued from page 52.)

1. Elongate subcylindrical macrotype eggs hatching to coloured maggots in long coiled strap-like uterus, the maggots deposited on foliage near hosts—Melanophryoniæ, Ernes-tiiæ, Micropalpiæ, Copecryptiæ, Servilliiæ, Larvævoriæ, Hystriciiæ, Saundersiiæ, Dejeaniiæ.

IV. HYSTRICIIDÆ

V. MASICERAT'DÆ

1. Microtype flattened—subovate eggs in coiled subtubular slender to fat uterus, incubated to full development of the shortened subovate maggot but not hatched therein, deposited on foliage near hosts to be swallowed by latter in feeding (chorion varying from gray to yellow and black in colour and exhibiting a great variety of minute structure) — Ceromasiopiæ, Epidexiiæ, Phasmophagiæ, Baumhaueriiæ, Ophirosturmiiæ, Eusisyropiæ Ommasiceratiæ, Dimasiceratiæ, Metopiopiæ, Euceromasiiæ, Euexoristiæ, Eumasiceratiæ, Masiceratiæ, Brachymasiceratiæ, Sturmiiæ Otomasiceratiæ, Chætophoroceratiæ, Gaediiæ, Germariiæ, Atactiæ, Triachoriæ, Belvosiiæ, Blepharipeziæ G.-U. s.

2. Microtype flattened elongate pointed or oval eggs, incubated and deposited same as preceding but maggot elongate, uterus very long and slender (chorion black)—Cnephalomyiiæ, Phasiatactiæ, Salmaciiæ.

3. Microtype slightly flattened, elongate-subcylindrical eggs, incubated and deposited same as preceding, uterus very long and slender (chorion smoky-yellowish) — Cylindromasiceratiæ.

VI. PHASIOPTERYGIDÆ

1. Microtype slightly flattened ovate-rounded eggs, growing in the upper part of uterus to macrotype elongate subcylindrical eggs which hatch in lower part of uterus

VI. PHASIOPTERYGIDÆ
(Continued from page 54.)

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to maggots with chitinized dorsal and lateral segmental plates, the maggots deposited where they must seek the host for themselves, the uterus extremely long and slender—Phasiopterygiæ.

1. Elongate subcylindrical slender macrotype eggs sharply pointed at anal end, hatching to white maggots with anal setæ borne at ends of anal stigmatic processes, the maggots deposited in choria on soil which they enter in search of white grubs, uterus fat and gut-like—Billæiæ, Microchaetiniæ, Mochlosomiæ, Dexiiæ (I am not certain that the last two groups possess the anal setæ of maggot, nor that the second group is parasitic in white grubs, but both are indicated by my studies).

VII. DEXIIDÆ

2. Elongate subcylindrical macrotype slender eggs, hatching to white maggots with anal stigmatic processes but lacking the anal setæ, the maggots deposited at entrances of galleries of woodboring grubs to which they penetrate, uterus fat and gut-like—Sardioceratiæ, Eutheresiiæ, Paratheresiiæ .

3. Elongate subcylindrical slender macrotype eggs, hatching to white maggots in the very fat gut-like uterus, the maggots lacking both anal processes and setæ and evidently deposited near the hosts—Tropidodexiiæ. (In this group

VII. DEXIIDÆ

the abdomen is rather densely set with subspinose macrochaetæ.)

4. Elongate subcylindrical macrotype eggs, hatching to coloured maggots in the fat gut-like uterus, maggots deposited near host—Myoceropiæ.

5. Very elongate subfiliform small macrotype eggs, hatching in the fat gut-like uterus to very slender subfiliform white maggots, which are deposited at weevil oviposition-punctures in various green fruits and buds, the maggots making their way to the weevil grubs inside—Myiophasiiæ.

VIII.. SARCOPHAGIDÆ

1. Elongate subcylindrical macrotype eggs, hatching to white or yellowish-white maggots in a cordate double-sac uterus, the maggots deposited on the food-substance—Sarcophagiæ G. U.

2. Elongate subcylindrical macrotype eggs, hatching to white maggots in a V-shaped double-sac uterus, the maggots deposited in the nests of various wasps and bees where they feed on stored insect food when such is present and on the early stages of the host—Metopiiæ Eumacronychiiæ, Para macronychiiæ, Miltogrammiæ, Macronychiiæ .

IX. MEGAPROSOPIDÆ

1. Elongate subcylindrical macrotype eggs, hatching in a very long irregular coiled uterus, the maggot clothed with long bristles—Megaprosopiæ.

X. OESTRIDÆ

1. Subcylindrical macrotype eggs rapidly tapered at anal end and with operculum at the obliquely-truncate cephalic end, incubated in uterus and attached by lateroanal surface to hairs of host by means of a viscid fluid—Gastrophiliæ.

2. Elongate subcylindrical pediceled macrotype eggs without operculum incubated in uterus and attached by the broad claspers of the pedicel to hairs of host by means of a viscid fluid, the chorion cleaving longitudinally for the escape of the maggot—Hypodermiæ.

3. Elongate subcylindrical macrotype eggs, hatching in uterus, the whitish maggots deposited free or in choria in the nostrils of host—Oestriæ.

XI. CUTEREBRIDÆ

1. Elongate subcylindrical large macrotype eggs with heavy chorion and operculum at cephalic end, incubated in uterus and attached by lateral surface to hair or skin of host by means of a profuse viscid fluid—Cuterebriæ, Dermatobiiæ.

SOME HETEROPTEROUS HEMIPTERA FROM SOUTHERN PINES, N. C.

BY J. R. DE LA TORRE BUENO, WHITE PLAINS, N. Y.

The Heteroptera listed below were all collected by Mr. A. H. Manee, of Southern Pines, N. C., whose labours have made possible the preparation of this paper. It is interesting not only on account of the records of distribution, data of great value in themselves, but also because it represents the fauna of a restricted area. It is hoped that it will be of value as a contribution to faunistics.